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# The use of piggyback lenses in optometric care

## Abstract

The use of piggyback lenses in optometric care

## Degree Type

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## Degree Name

Master of Science in Vision Science

## Committee Chair

Patrick J. Caroline

## Subject Categories

Optometry

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# **THE USE OF PIGGYBACK LENSES IN OPTOMETRIC CARE**

*By*

**ANDY J. OLSON**

A thesis submitted to the faculty of the  
College of Optometry  
Pacific University  
Forest Grove, Oregon  
for the degree of  
Doctor of Optometry  
May 2007

***Advisor:***

***Patrick J. Caroline***

## Signatures

Examiner:

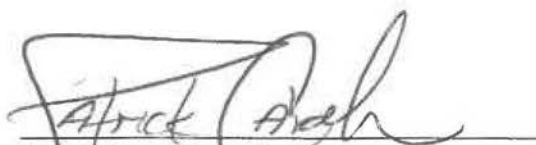
A handwritten signature in dark ink, appearing to read "Andy Olson", written over a horizontal line.

Andy Olson

12/21/06

Date

Advisor:

A handwritten signature in dark ink, appearing to read "Patrick J. Caroline", written over a horizontal line.

Patrick J. Caroline

12/22/06

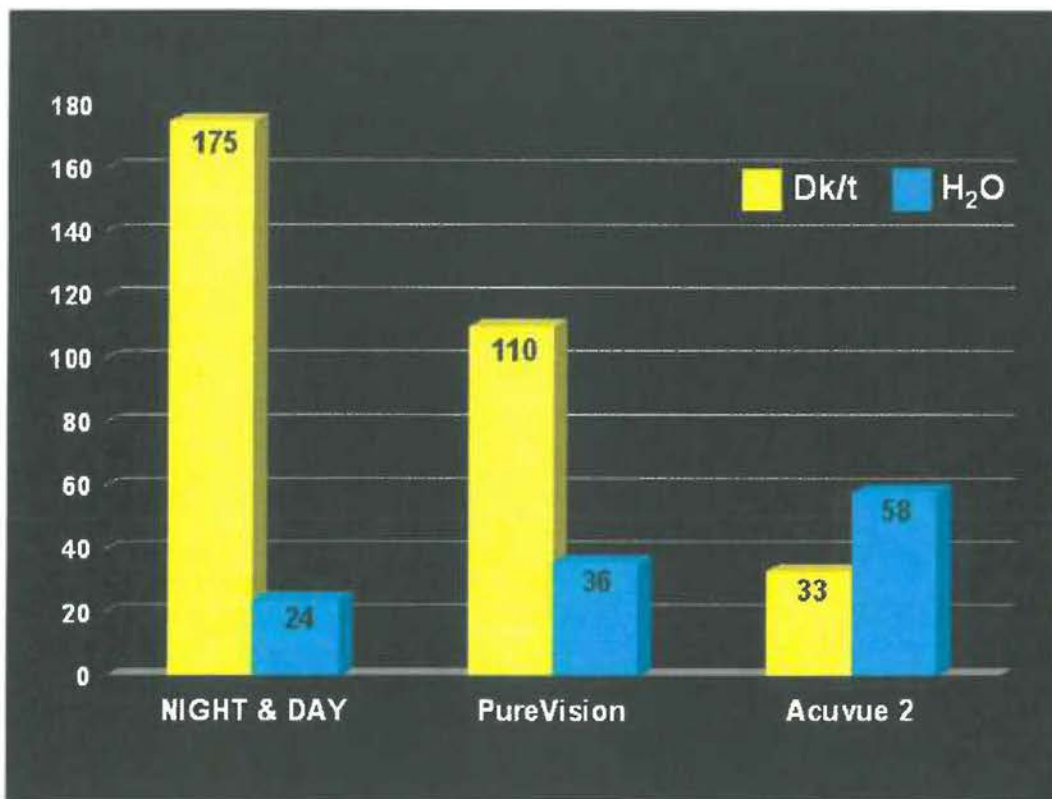
Date

Andy Olson grew up in the towns of Tucson and Flagstaff, Arizona. In 1999, he attended the University of Arizona in Tucson and majored in Molecular and Cellular Biology. He and his wife, Lynda, have two children, Scarlet Eclipse and Angel Gray. He plans on practicing full scope optometry in the Northwest where he can continue to enjoy the close proximity of forests, oceans, and mountains.

I would like to thank Pat Caroline for his priceless assistance in this project. Also, I would like to thank my family for their support throughout my experience at Pacific.

## Introduction

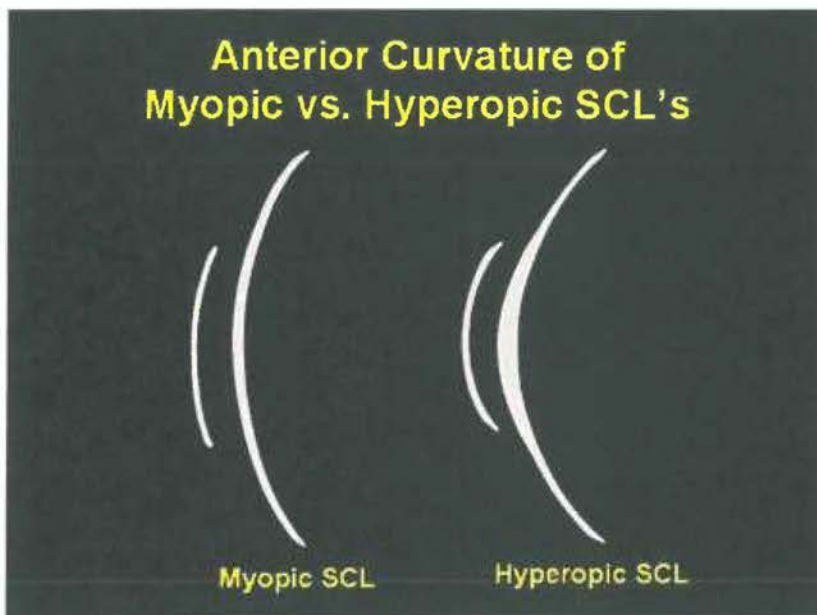
The term “piggyback” was first introduced to the contact lens industry in the 1950’s by the Mueller-Welt Company to describe a rigid contact lens fitted onto another rigid contact lens to produce a bifocal effect. However, since the early 1970’s the term has been universally used to describe the use of a soft contact lens with a rigid lens fitted on top. Early piggyback systems consisted of thick, low Dk, soft lenses and low Dk silicone/acrylate lenses. It is not surprising that this combination of hardware frequently resulted in corneal hypoxia and neovascularization thereby limiting the usefulness of the modality. Today, with the advent of hyper Dk soft and RGP lenses, the dual lens system is now enjoying a rebirth particularly for patients experiencing comfort or lens position issues following refractive surgery.



Piggyback lenses are primarily used to improve patient comfort or aid in RGP lens positioning when the anterior corneal surface has been compromised i.e. post refractive surgery, keratoconus, pellucid marginal degeneration or other conditions affecting the topography of the cornea.



In a number of these situations, it is helpful to create a new surface to the eye by utilizing the anterior soft lens power. In other words, a flatter anterior surface will result from the use of a minus power SCL while a steeper anterior surface will result from the use of a plus powered soft lens.

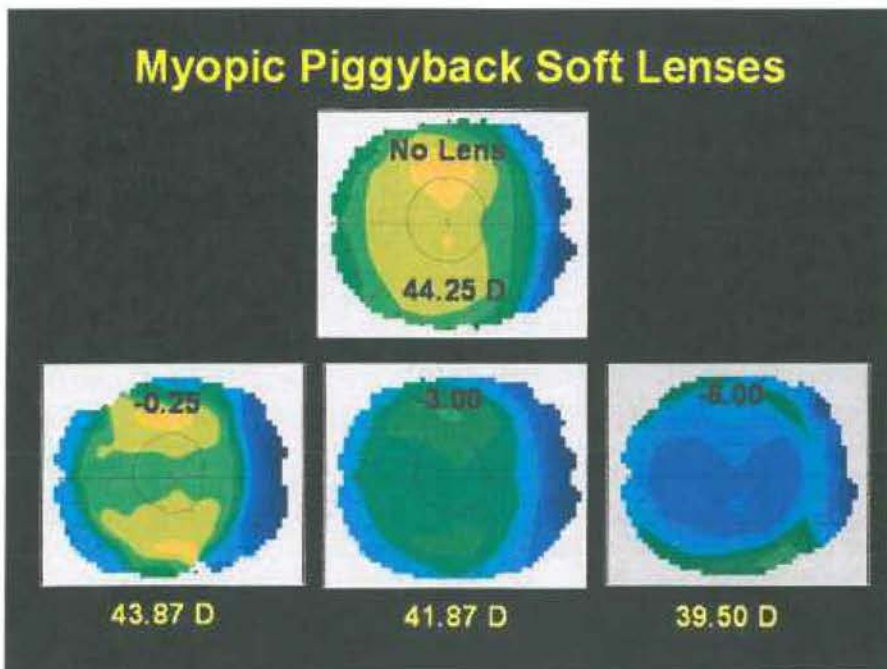




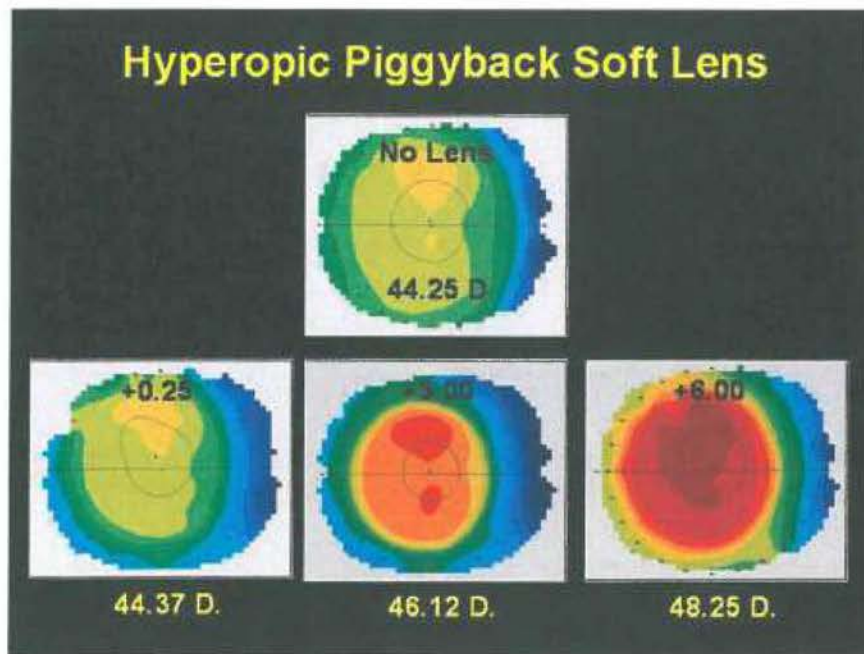
## Traditional Piggyback Lens System

The traditional piggyback system consists of a high Dk silicone hydrogel soft lens over which a high Dk GP lens is fitted. The best approach to fitting these lenses begins with the diagnostic fitting of the soft lens to optimize lens movement and position. Clinical experience has taught us that it is often best to select a silicone hydrogel soft lens with low to moderate plus power so that the anterior surface of the soft lens better emulates the prolate shape of the normal cornea.

The photograph below illustrates the anterior surface flattening effect associated with the fitting of myopic CIBA Night & Day lenses. With no lens in place, the apical radius of curvature of the patient's cornea is 44.25 D. the central radius flattens with the increase in minus lens power, -0.25 (43.87 D), -3.00, (41.87 D), and -6.00 D (39.50 D).



The photograph below illustrates how the anterior surface effectively steepens with the fitting of hyperopic CIBA Night & Day lenses. With no lens in place the apical radius of curvature of the patient's cornea is again 44.25 D., however, the central radius effectively steepens with the increased plus power, +0.25 (44.37 D), +3.00, (46.12 D), and +6.00 D (48.25 D).

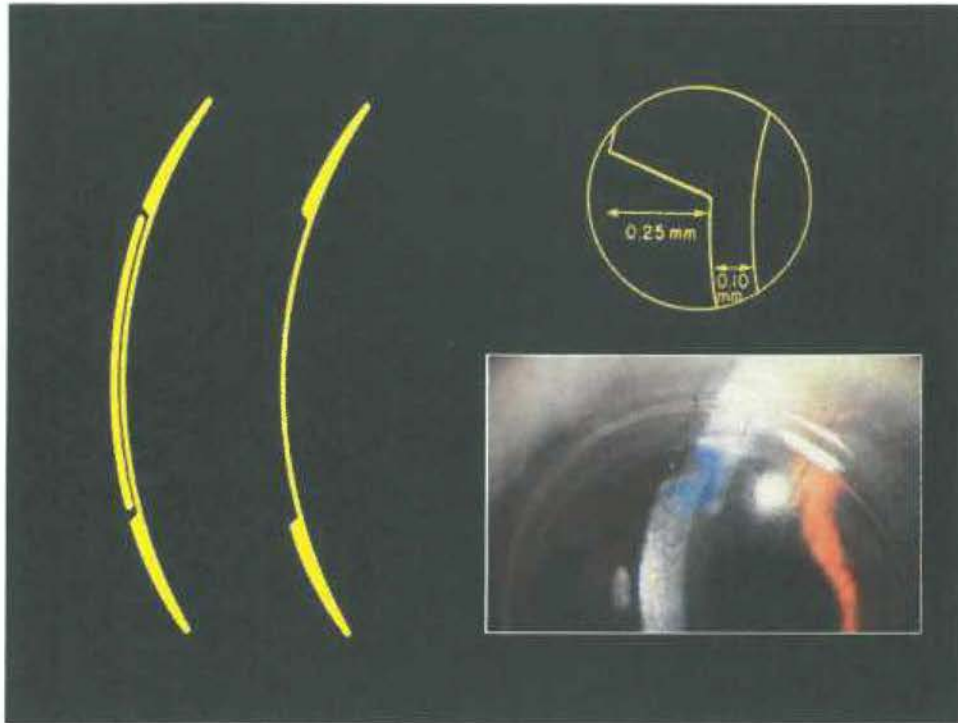


It is clear from these examples that when fitting piggyback lenses, the curvature of the anterior soft lens and the overlying RGP lens, will be influenced by the power of soft lens and to some extent, the curvature of the underlying cornea. This change in surface curvature can prove to be advantageous in cases involving post refractive surgery in which a steeper radius of curvature may be desired or in keratoconus where a flatter fitting surface may be desired.

This is followed by keratometry or videokeratography over the anterior surface of the soft lens to determine the radii of the “new” corneal surface. An RGP lens is selected with a base curve radius equal to the flat K and a diameter of approximately 9.0 to 9.5 mm. The base curve is adjusted until an appropriate lens-to-lens fitting relationship is established. An over-refraction is performed to determine the final power of the RGP lens. The RGP lens can be manufactured in a high Dk material with customary peripheral lens and edge configurations.

### Custom Piggyback Lens System

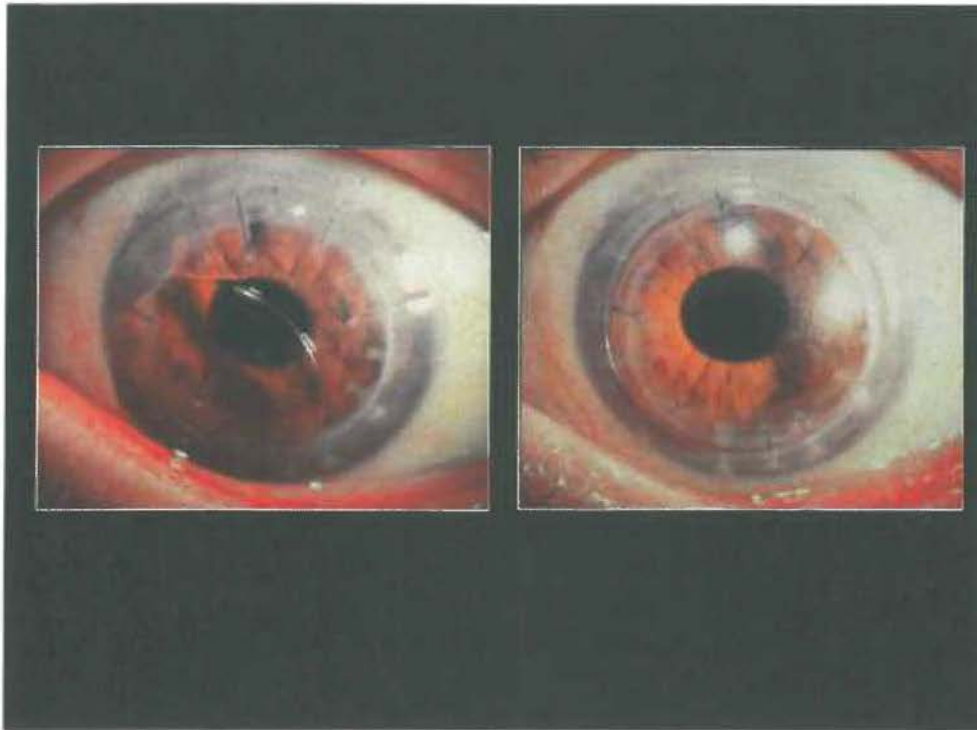
The custom piggyback soft lens differs from the traditional system in that it incorporates a circular, recessed depression into the center of the soft lens. Within the boundaries of the cut out, a high Dk RGP lens is fitted. The system provides optimal performance by virtue of the now centered RGP optics and enhanced comfort through the bandage effect of the soft lens.



In the United States, the custom piggyback soft lens is manufactured by X-Cel Laboratories in Duluth, Georgia. The soft lens is available in a wide range of parameters, including BOZR from 6.00 to 11.00 mm and lens diameters from 12.5 to 16.5 mm. The recessed cut-out can be manufactured in diameters of 7.5 to 11.5 mm. The fitting criteria for the soft lens is identical to that of any lens, with movement and centration the primary fitting objectives. Diagnostic fitting of the soft lens is enhanced by inserting any rigid lens into the recessed cut-out of the soft lens to better mimic final lens weight and lid/lens interaction. Once the appropriate soft lens fit has been established, the rigid lens can be removed and K readings performed over the central portion of the soft lens. A diagnostic RGP lens with a base curve radius equal to the flat K is inserted into the cut-out and its fitting relationship evaluated and adjusted. It is important to select an RGP with an overall lens diameter 1.0 mm smaller than the cut out diameter to allow for some movement and tear exchange within the soft lens cut-out boundaries. For example, if the cut-out diameter is 9.5 mm, the RGP lens diameter should be 8.5 mm.

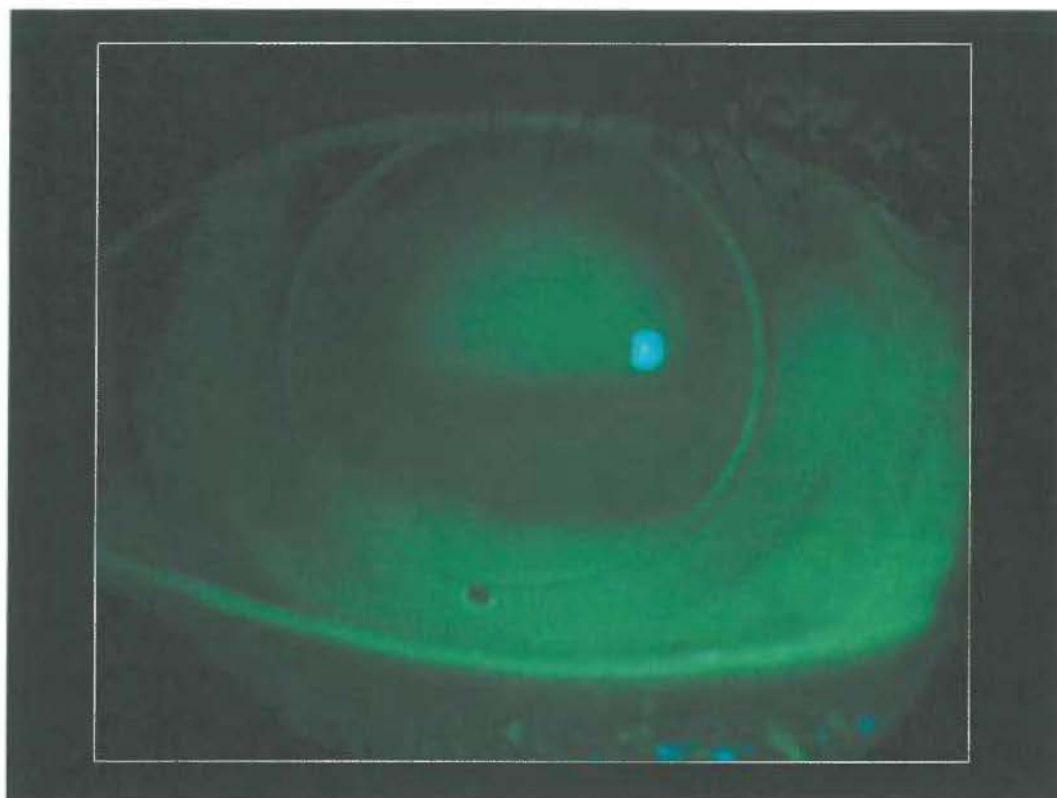


The left image shows a spherical GP lens design on the patients left eye and the right image shoes the final piggyback lens combination.



### **Advances in Hybrid Lens Designs**

In September 2001, a California based research group called Quarter Lambda Technologies began development of a new high Dk hybrid lens called SynergEyes. The lens incorporates an 8.2 mm high Dk rigid center, (Paragon HDS 100, Dk 100) and a 31% water non-ionic soft lens skirt. The overall diameter of the lens is 14.5 mm.



We have successfully used this lens design for patients following refractive surgery especially those with irregular astigmatism or comfort and centration issues with traditional RGP lens designs. The SynergEyes is available in three lens designs for the post refractive surgery cornea. *SynergEyes A*, is the standard aspherical design ideal for post surgical corneas in which there is minimal topographical difference between the central and mid-peripheral cornea. The *SynergEyes PS*, design incorporates a flatter radius of curvature in the center of the RGP lens and a steeper curve in the mid-peripheral radius. This lens design is ideal for patients with highly oblate corneas following refractive surgery. The *SynergEyes KC*, has been designed specifically for keratoconus however, this lens has proven extremely valuable in managing patients with LASIK-induced keratectasia, a condition in which the thinned post-LASIK cornea begins to bulge anteriorly similar to that seen in keratoconus.

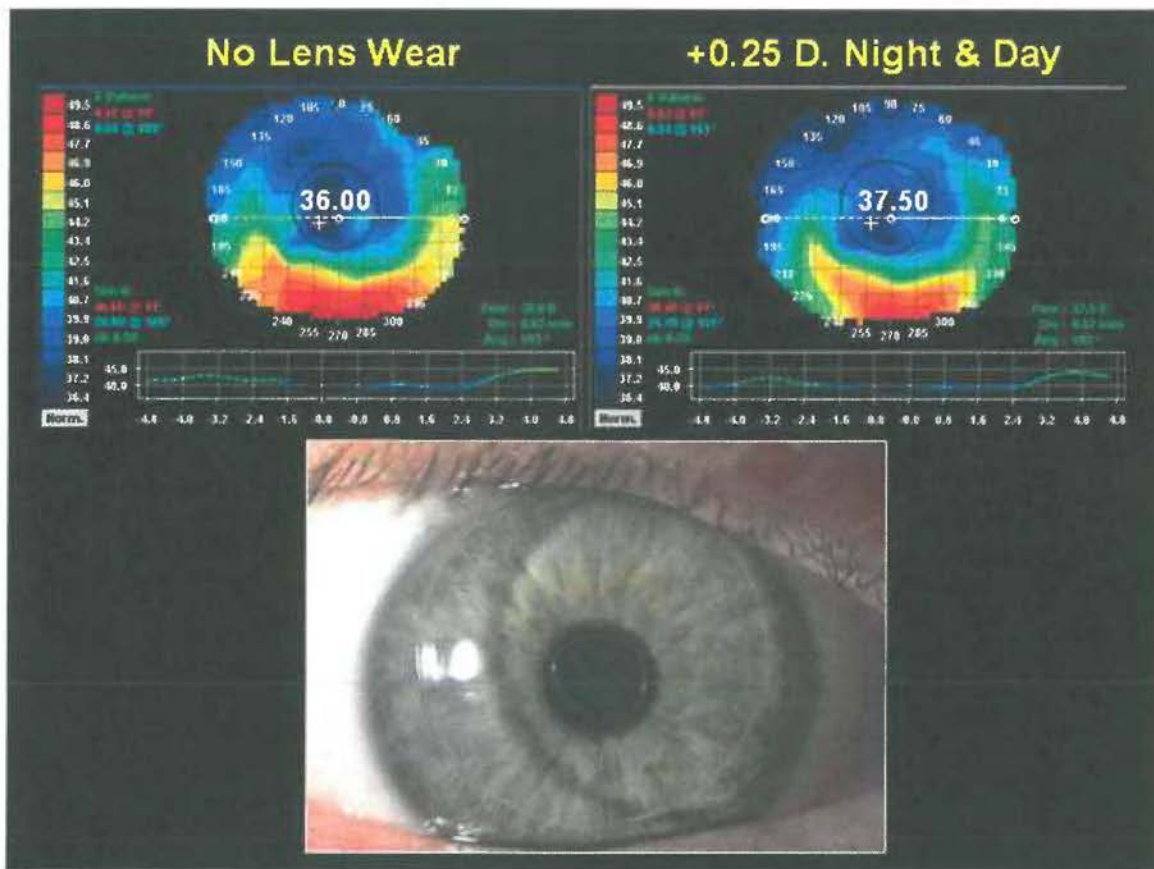
Three, 12 lens diagnostic sets are used in fitting the SynergEyes lenses. The fitting procedure begins by selecting a diagnostic lens with a BOZR equal to the radius of the mid-peripheral cornea approximately 4.0 mm from the center. High molecular weight fluorescein is placed into the bowl of the lens and the lens is placed on the eye and allowed to equilibrate. The RGP portion of the lens should exhibit central apical clearance and mid-peripheral lens bearing. The soft lens skirt should exhibit 0.25 mm of blink induced movement. The lens-to-cornea fitting relationship is evaluated with the aid of a high molecular weight fluorescein.

## Case History

A case in point is patient JS who underwent bilateral radial keratotomies in 1992. Both eyes healed uneventfully and today his uncorrected visual acuity's are, right eye, 20/25 and left eye, 20/200. Keratometric readings of the right eye are 40.00 @ 160 / 40.87 @ 70, with an apical power of 39.25 D., left eye 39.87 @ 109 / 40.62 @ 19 with an apical power of 36.00 D. His best spectacle correction is OD +0.50 -0.75 x 150, 20/20, OS +4.25 -0.50 x 100, 20/25.

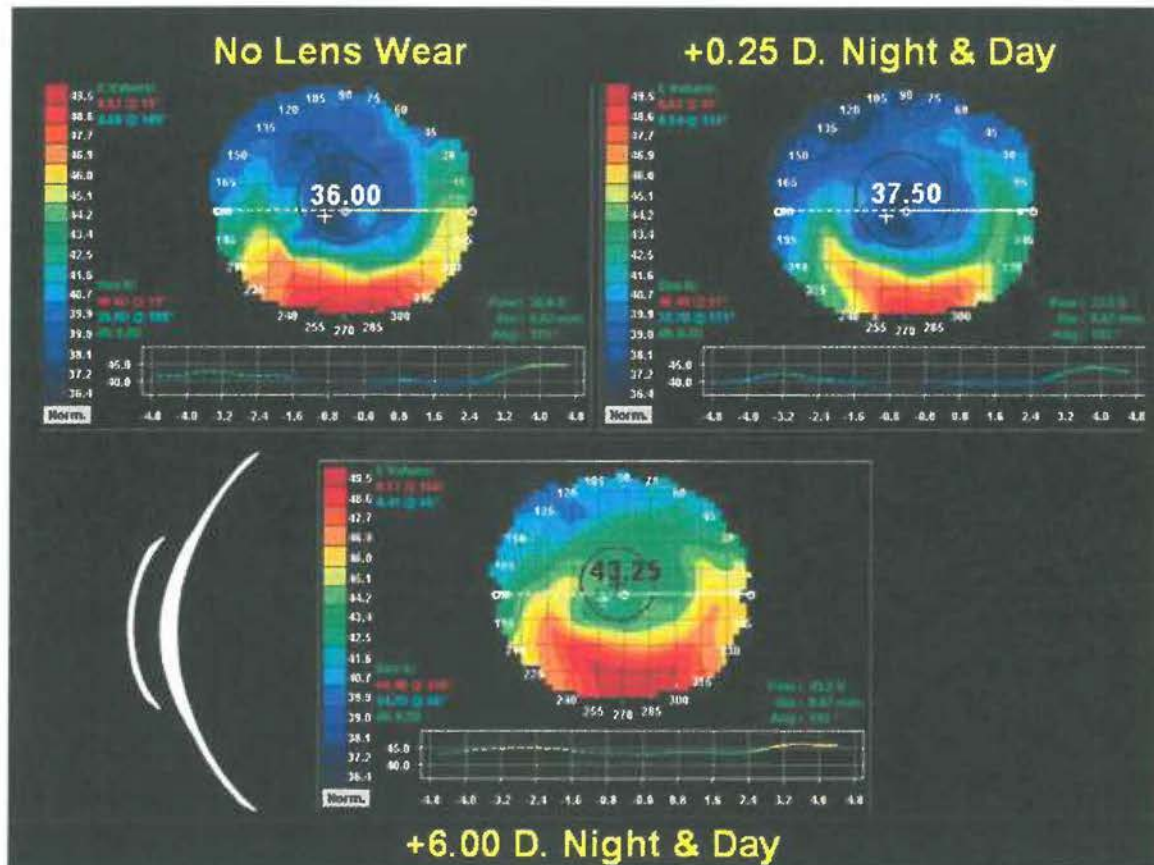
Due to the surgically induced anisometropia, the patients left eye was fitted with a number of spherical, aspherical and reverse geometry GP lens designs however, he was never able to achieve adequate, all day, comfort. It was decided that the patient might benefit from a trial of a piggyback system.

In the figure below, the top left map shows the topography of the patients left eye without contact lenses. The top right map shows the topography over a +0.25 D. Focus Night & Day lens. Note the change in apical curvature from 36.00 D. to 37.50 D. A GP lens, fitted with alignment to the mid-peripheral cornea (BC 43.50), resulted in a 3.0 mm bubble trapped beneath the center of the lens.

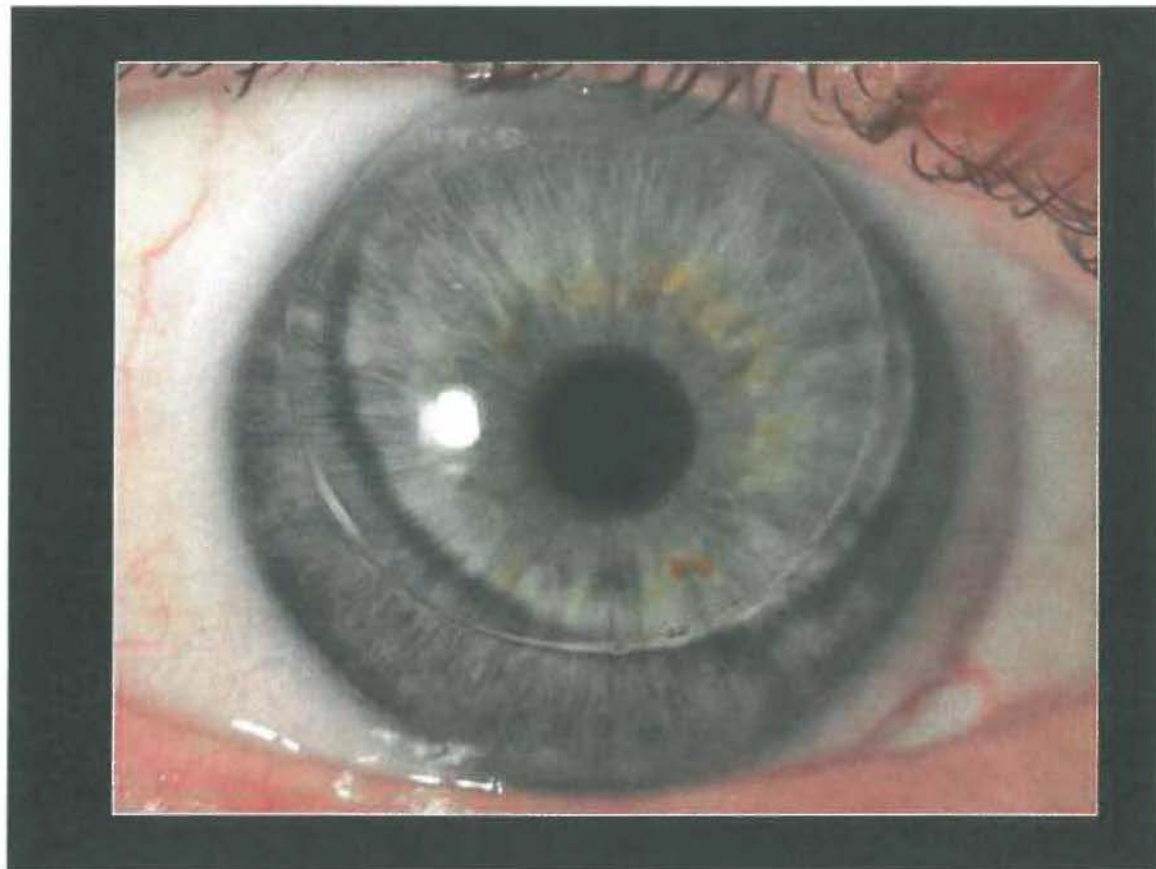




At this point two clinical options are available #1 design the GP lens in a reverse geometry configuration or #2 alter the profile (power) of the underlying soft lens to create a steeper anterior fitting surface. The patient was subsequently fitted with a +6.00 D. Focus Night & Day lens. Corneal mapping over the +6.00 D. lens, revealed a central apical radius of 43.25 D.



A standard, aspheric, GP lens was fitted to the anterior surface of the soft lens and today, the patient enjoys all day lens comfort and 20/25 vision.

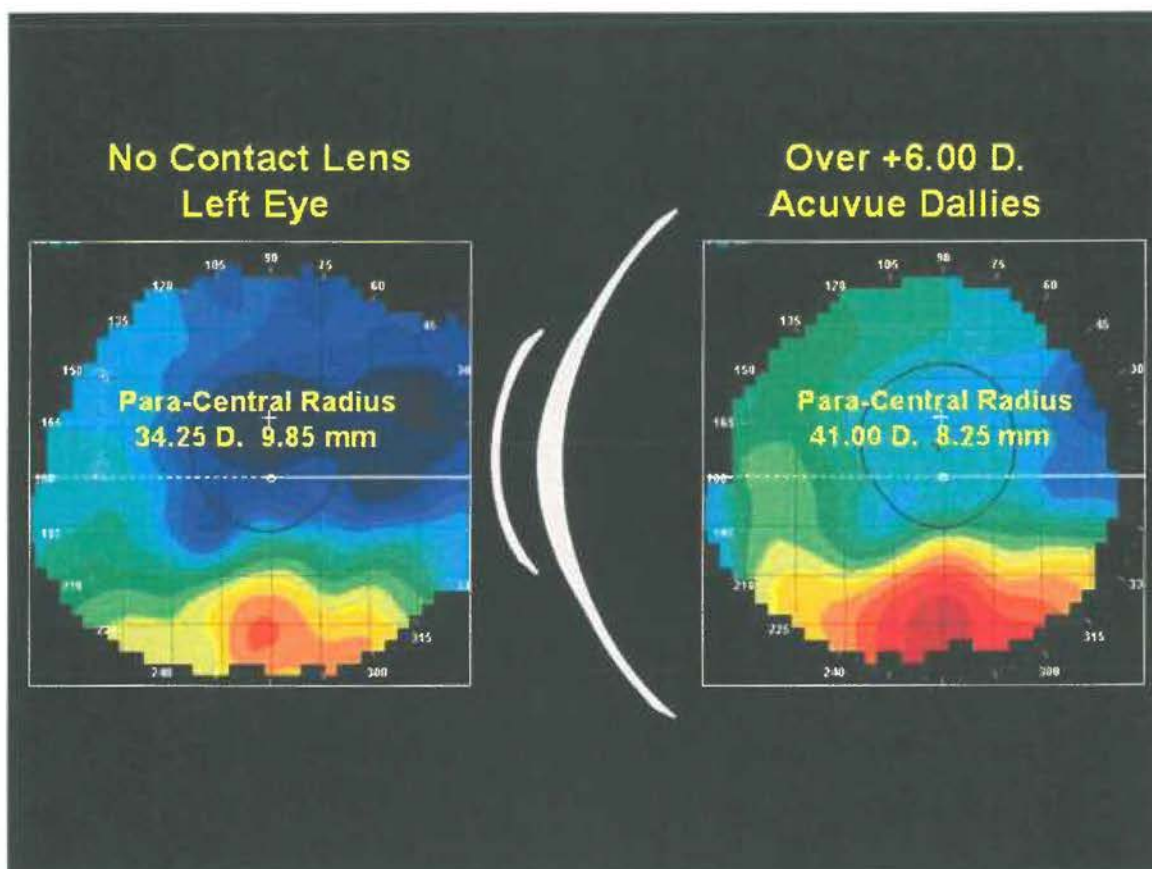


Historically, we have all been concerned with the physiologic performance of thicker, plus powered lenses, especially on compromised corneas. However, in a 2002 study by Kollias, Mutti at The Ohio State University, they found that plus powered (+6.00 D.) silicone hydrogel lenses induced corneal swelling comparable to that induced by no lens wear.

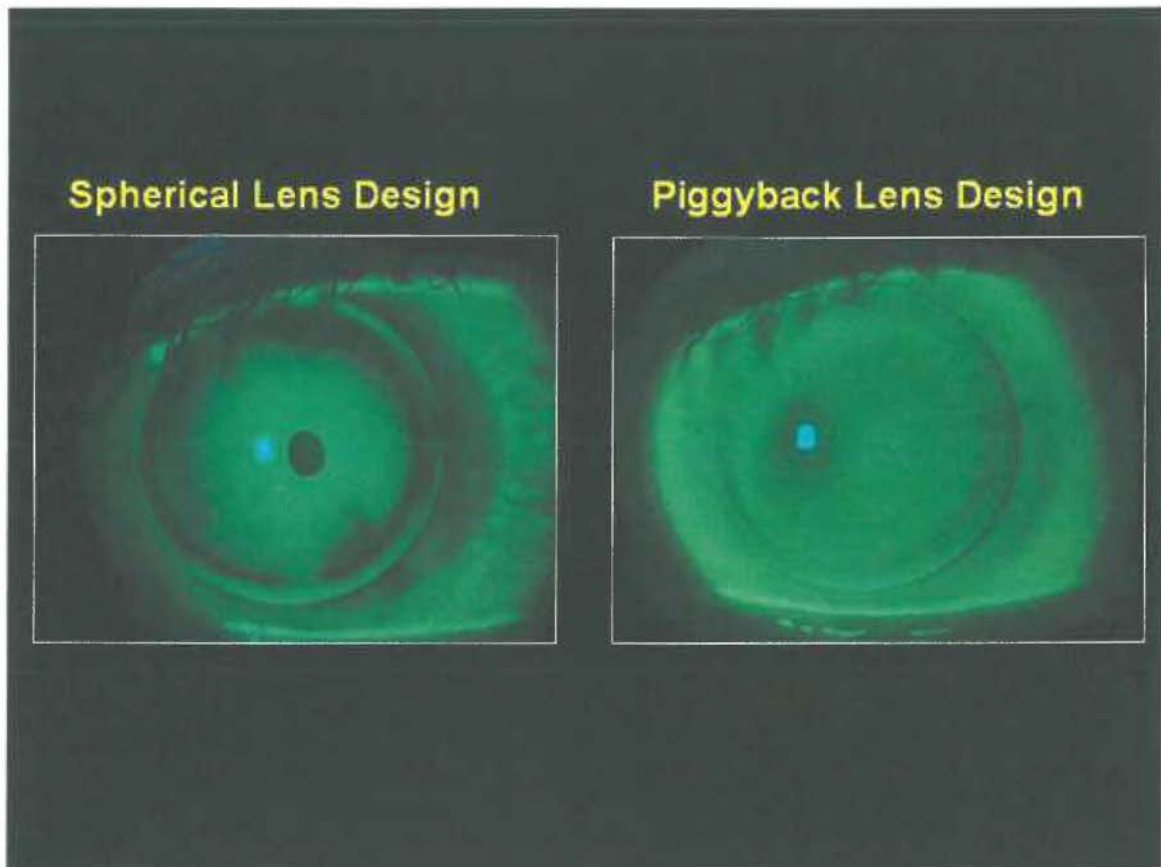
Another patient, DH, a 44 year old police officer presented with a history almost identical to the above patient. The patient underwent RK 15 years ago and experienced corneal flattening to the left eye. Corneal topography revealed simulated "K's" OS of 37.62 @ 167 / 38.50 @ 077 with a para-central radius of 34.25 D. The manifest refraction was OD +0.50 sphere 20/20 and OS +5.25 - 0.25 x 175 20/25. Again, based on this data and the unsuccessful attempts to gain comfort in other contact lens modalities, it was considered that this patient might benefit from a piggyback system.



The figure below shows the patients pre-fitting corneal topography with a para-central radius of 34.25 D. 9.85 mm. Corneal topography of the same eye, over a +6.00 D. Acuvue Dailies soft lenses revealed a para-central radius of 41.00 D. 8.25 mm.



The figure shows a spherical GP lens design on the patient's left eye with a base curve radius of 43.00 D, 7.85 mm, with a large, fixed central bubble. The right photo demonstrates the 43.00 D 7.85 mm GP lens on top of the +6.00 Acuvue Dailies. Today, the patient's VA with the lenses is stable at 20/20 and he now enjoys all-day lens comfort.



These two cases demonstrate how the use of plus powered high Dk soft lens (one a Focus Night & Day and the other an Acuvue Dailies) to create a new anterior fitting surface, could be used to steepen anterior corneal topography in individuals who exhibit radical corneal flattening post radial keratotomy.

### Summary

The use of piggyback lenses may be one of the most underutilized modalities in our optical management of the compromised cornea. With today's high Dk materials and advanced lens designs, we have found ourselves successfully utilizing the dual lens system more frequently than ever. With increased technology and wider use, the potential to provide care to a historically complex patient population will grow to exciting new heights.